FIBRAMATIC

From the roving to the complete blade

MTORRES

01 The challenge

Back in 2009, infusion was starting to be the reference process in the wind blades manufacturing, as it had been then for a while in boat building. But, at that time, the level of automation was almost negligible.

By then, MTorres had been working in infusion for more than 5 years, and had put in the market the first AFP machines for prepregs, as an alternative to our well-known ATL machines.

In this scenario MTorres started a really challenging project called “Fibramatic” with Gamesa, with the target of automating the manufacturing of blades. The idea was to transfer MTorres experience in layup, infusion and assembly from aircraft industry to wind energy market.

Process was simple: automated layup on the moulds, infusion and curing, demoulding and assembly on a dedicated jig. Quality could be improved thanks to automation and geometry due to the use of a jig. But the initial landscape was stark, and almost every aspect of the project was a challenge…

The answer 02

When we started, no AFP head for dry tape was available, so we had to develop the very first machine in the world, having into account that there were some other differences, apart from material, to standard AFP aeronautical machines: now, the width of the tape and the areal weight were much bigger, and the floatability of each geometry, especially close to the root. A final configuration of 12 x 50 mm tapes was chosen. On the other hand, dry fiber had no tackiness, so we had to manage to keep it in place… Angle cutting was also added to the machine, in order to keep scrap to its lowest possible value.

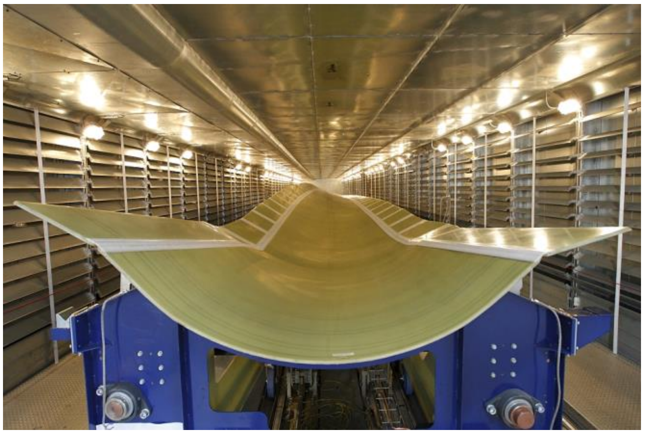
When we went to the market, looking for glass fiber dry tape, the scarce possibilities did not have the stiffness required to be used in AFP. For this reason, Mr. Torres, founder, owner of the company and R&D leader, decided that we would develop our own material, so that we could engineer it, not only for the adequate behaviour in the AFP machine, but also in the through-the-thickness permeability, needed for the infusion of the thick root area without the help of any internal flow media and just from one side. The setup and tests done at that time in the loom, would lead some years later to the development of a new conditioning line (same specs but higher speed and lower processed material costs…). In short, we developed a process from the very roving to the complete blade…

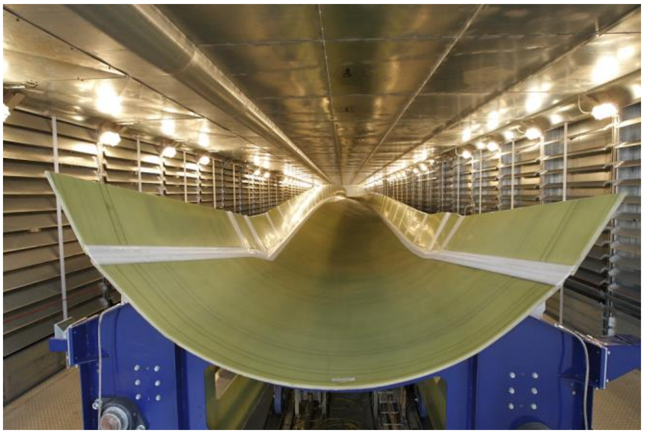
There were some areas in the blade that posed a challenge for net shape automated layup: root area (due to high curvature and access of the AFP head), leading edge, blunt trailing edge at the inboard sections and flanges of the spars (due to the size and radius). In order to solve the automation of these areas, some adjustments on the parts definitions were done and new mould technology was developed.

Main adjustment was to manufacture the leading edge as an additional part, so that the problem of the high curvature was solved with an easy room temperature forming, besides increasing the geometrical accuracy in this area critical for aerodynamic performance, and increasing as well the structural robustness, taking the bonding area away from the maximum shear zone.

The other key for automated layup was the development of foldable moulds, both for skins and spars. These moulds could be unfolded following a 3D axis to the layup geometry (flanges were put tangent to the web or central skin area) so that AFP head could lay easily. Once the lamination was finished, vacuum bag was installed and a certain level of vacuum was applied. Under these conditions, the mould was folded back to the part geometry. Dry tape allows for easy room temperature draping. Once the mould was returned to the original geometry, infusion and curing was done. This development made demoulding also possible for some geometries, that were impossible otherwise.

Since the moulds had to be moved into the AFP, it was decided that an oven would be used, instead of heated moulds. Infusion and curing were done in the oven.

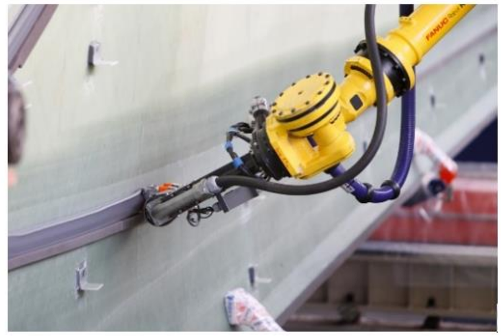




03 More than just a lay-up

Once the parts were demoulded, an assembly jig was used to bond all the parts together. This is not usual in wind energy, but it is in aircraft manufacturing. This way, moulds were used only for the part manufacturing, leaving more time for these tasks. This was the first time, as far as we knew. Another advantage of the use of a jig, besides getting more productivity from the moulds, was the increased geometrical accuracy, as the part geometry could be adjusted and best fitted.

In order to avoid a secondary heating of the bonded areas, room temperature curing methacrylate adhesive was used. This adhesive was not common in blades, but it was in boatbuilding, where all the advantages of its flexibility were used. In order to increase quality, automatic adhesive application with robots was developed. Bond line thickness and width was controlled and optimized.



The remarks 04

Summing up, a completely different manufacturing approach was used. New technologies were developed, from the conditioning of the fiber and the use of AFP, to the use of an assembly jig with a new adhesive. Tolerances and behaviour of the blade under extreme and fatigue loads were excellent from the very first prototype, making this project a complete success. A job focused on getting the best and most suited options from different sectors for each stage of the project to achieve the best performance. Another proof that when you look for disruptive, game-changing developments in composites, MTorres is your essential partner.

More information at: